A New Pulse-Based E-R-μ Method for Predicting the Peak Seismic Response of Highly Nonlinear Bridge Structures

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Abstract

Simplified analysis methods used in AASHTO, CAN/CSA-S6 and EC8 codes for the seismic design of isolated structures typically rely on a linearization of nonlinear systems and assume that the peak response can be obtained from a steady-state dynamic response centered about the origin of the force-deflection response of the system. This assumption, while adequate for a certain range of nonlinear systems, leads to potentially large inaccuracies, especially for highly nonlinear systems. The article presents a new pulse-based *E-R-μ* method that was developed to overcome these limitations and achieve better peak response predictions. The method is based on the response of nonlinear systems to single acceleration pulses which more realistically reflects the effects of ground motions on seismically isolated structures. In addition, the method does not require iterations, which represents a major advantage compared to current iterative linearization approaches. In the article, assumptions of current code methods are summarized. Energy based concepts forming the basis of the new *E-R-μ* method are introduced. The method is then described and validated against the results from nonlinear time history analyses for a large number of isolated bridge models. The method is also applied and validated for an archetype isolated bridge case. For this structure, the proposed *E-R-μ* method is found to give an upper bound prediction of the displacement demand that is obtained from nonlinear dynamic analysis.

Keywords: Seismic design; Bridge structures; Seismic isolation and supplemental damping devices.

1 Introduction

Seismic design provisions in bridge codes worldwide generally include simplified analysis methods for the design of isolated bridge structures. The simplified methods in AASHTO [1], CAN/CSA-S6 [2] and EC8 [3] are based on the response of a linear system with effective lateral stiffness and equivalent viscous damping representing the energy dissipation capacity of the system evaluated at peak displacement. These methods assume that the peak response can be

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